25. *Fading of Group C.*

Sometimes in examining colours of group C, advantage may be taken of the different rate at which their acid solutions decompose and fade, when a considerable quantity of sulphite of soda has been added to an acid solution. The two solutions should be made as nearly equal as possible in all respects, and then the rate of fading may prove that they are very different, or may show that one is a mixture. After fading, the addition of excess of ammonia may show valuable facts. For example, the colour of the root of the red beet (*Beta vulgaris*) is pink, but that of the leaves is red, the spectrum differing from that of the root merely in having the blue end much absorbed. On keeping acid solutions of both to which sulphite of soda has been added, that of the root becomes colourless, and that of the leaves yellow; and thus, considering that acid solutions of colours belonging to group C are very rarely pink, it is almost certain that the colour of the leaves is the same as that of the root, but modified by the yellow colour so common in leaves.

26. *Conclusion.*

Such, then, is a general outline of the method which I have hitherto found the most convenient in studying different colouring-matters, and for determining to what individual species any particular colour may belong. I need hardly say that it is just the sort of qualitative analysis to employ in detecting adulterations in many substances met with in commerce, as well as in inquiries where very small quantities of material are at command. By this method we might be able in a few minutes to form a very satisfactory opinion, or at least one that might meet all practical requirements, and even under unfavourable circumstances we might narrow the inquiry to a surprising extent; and if this can be said even now, surely further research cannot fail to make it most useful in cases where ordinary chemical analysis would be of little or no use.

The Society then adjourned over the Easter recess to Thursday, May 2.

May 2, 1867.

Lieut.-General SABINE, President, in the Chair.

In conformity with the Statutes, the names of the Candidates recommended for election into the Society were read from the Chair, as follows :—

William Baird, M.D.
W. Boyd Dawkins, Esq.
Baldwin Francis Duppa, Esq.
Albert C. L. G. Günther, M.D.
Julius Haast, Esq., Ph.D.
Captain Robert Wolseley Haig, R.A.
Daniel Hanbury, Esq.
John Whitaker Hulke, Esq.
Edward Hull, Esq.
Edward Joseph Lowe, Esq.
James Robert Napier, Esq.
Benjamin Ward Richardson, M.D.
J. S. Burdon Sanderson, M.D.
Henry T. Stainton, Esq.
Charles Tomlinson, Esq.

A letter from the Foreign Office, addressed to the President, was read, communicating the following paragraph from the 'Moniteur,' transmitted by H. M. Ambassador at Paris:—

"Paris, le 27 Mars.

"L'Empereur, dans sa sollicitude pour tout ce qui intéresse la science et les relations commerciales, a décidé que des officiers de la marine et des ingénieurs hydrographes seraient envoyés sur différents points du globe, dans le but de déterminer par des observations astronomiques un certain nombre de méridiens fondamentaux qui serviront à assurer la position géographique des lieux intermédiaires.

"Ce travail important permettra de corriger la Table des latitudes et longitudes insérée dans la *Connaissance des temps*, et dont les erreurs ont été signalées dans un rapport addressé au ministre de l'instruction publique par le président du Bureau des longitudes."

The following communications were read:—

I. "Optics of Photography.—On a Self-acting Focus-Equalizer, or the means of producing the Differential Movement of the two Lenses of a Photographic Optical Combination, which is capable, during the exposure, of bringing consecutively all the Planes of a Solid Figure into Focus, without altering the size of the various images superposed." By A. CLAUDET, F.R.S. Received April 8, 1867.

When a solid figure is brought too near the object-glass of a camera obscura, the difference of focus for its various planes is comparatively so great, that it is impossible that all the images should be equally well defined. Hence, in the case of photographic portraiture, there is a want of harmony in the representation of the various parts; some are too sharply delineated, and some others are confused in proportion as they are more and more distant from the plane in focus. But there is another defect which is the consequence of the difference of distance of the various planes bearing too great a proportion to the distance of the whole, which is that the nearest parts of the figure are too much enlarged, and the furthest too much reduced.

In a paper I read at the British Association at Nottingham in 1866, I proposed a plan to obviate these defects, which consisted in bringing all the planes consecutively into focus, by moving, during the exposure, the tube of the lens or the back frame of the camera; the consequence of which was, of course, that the planes were also during that movement brought out of focus; so that a sharp image of every plane was impressed upon a confused image; but they were all in the same degree in that mixed state, and the result was an equality of effect producing harmony in the whole, and that kind of softness in the picture so much approved by artists, as resembling, more than the sharpest photographs, the effect that they aim at producing.

The original simple idea of equalizing the focus of the various planes by moving either the frame holding the plate, or the tube of the lens, during the exposure had, it appears, occurred to several persons engaged in photographic pursuits (of which I was not aware before reading my paper); but it is certain that the plan had never been practically and generally adopted, and that, at all events, no specimens of the process had at any time been exhibited in public, probably because it presented several difficulties which could not be easily overcome. The greatest of these difficulties I soon found during my investigations, which was that, in changing the focal distances merely by moving the frame or the tube, the size of the various superposed images was unavoidably reduced or increased according to the alteration of focus during the movement applied.

Therefore I turned my attention to the means which might be found capable of avoiding this defect, and a fortunate idea presented itself, by which I found that it was possible to preserve the size of the various images during the adaptation of the focus to the different planes of the figure.

The desideratum was, when changing the focus, to increase the power of the double lens for the planes the most distant and to reduce it for the nearest planes. At first this seemed to be an impossibility. But in considering the subject attentively, I was suddenly struck with the fact that the power of any double combination of lenses being proportionate to the distance which separates the two lenses greater when they are more separated, and smaller when they are less separated, it was possible to alter the power of the combination by changing the distance between the two lenses.

Therefore, if, instead of moving the whole tube containing the two lenses, we move only the back lens nearer the plate, when we want to focus for more distant planes, we increase at the same time the power of the double combination, and consequently the size of the image; and if we move the lens further from the plate, when we want to focus for the nearest planes, in doing so, by reducing the separation of the two lenses, we reduce the power of the combination, and consequently also the size of the image. This is a most fortunate property; for by this means it is possible not only to equalize the definition of the various planes, but at the same time to equalize the size of their images, and consequently to avoid the exaggeration of perspective by which the nearest planes are increased, and the furthest disproportionately reduced, a defect which is so detrimental to the appearance of large photographs.

I submitted my plan to M. Voigtlander, the celebrated optician, and I had the satisfaction to meet with his entire approbation. He found that I had solved the problem in a way which was perfectly correct and sufficient in practice. But wishing to investigate the question from a higher mathematical point of view, and being unable from indisposition to go himself into the subject, he charged his step-son, Dr. Sommer, Professor of Mathematics at the Carolinian College of Brunswick, well versed in all the

questions of optical photography, to calculate the result of the gradual increase and reduction of the power of the double combination, in conjunction with the alteration of focus. Dr. Sommer entered thoroughly into the subject, and soon sent me a series of elaborate formulæ, showing that, although for all practical purposes in photography the movement of one of the two lenses, as I had proposed, fulfilled the object I had in view, still he found that a more scientific consideration of the subject called for a modification in my plan; which was that, instead of moving only one of the lenses, the same degree of their separation should be imparted by moving the two lenses in contrary directions from the fixed centre of the combination, and in different proportions, according to the distance of the object. These differential proportions were indicated in a table calculated by Dr. Sommer which he sent me.

This presented another difficult and unexpected problem, the solution of which was indeed most perplexing. But I did not like that it should be said that my plan was not completely in accordance with the mathematical laws of optics; and I set to work at finding a mechanical means by which I could avail myself of the scientific calculations of Dr. Sommer.

I have found such means; and it turns out indeed that by my mechanical construction the differential movement can be effected, not only as readily and easily, but with a greater command and steadiness than by moving only one lens. The following is a description of the arrangement:—

Description of the Focus-Equalizer.

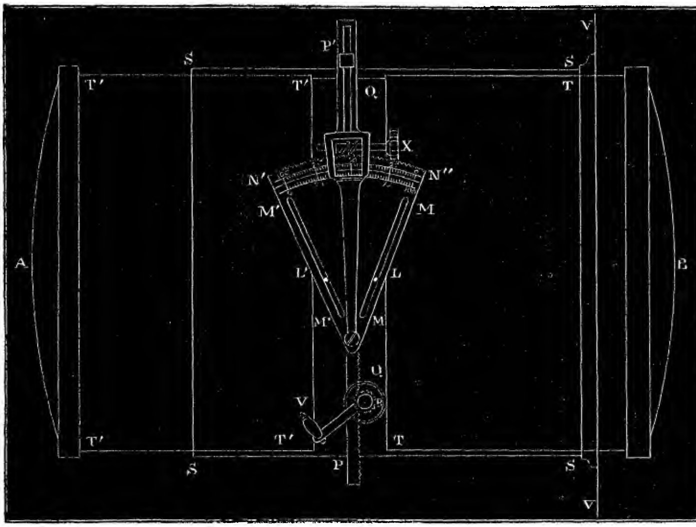
The tube, containing at each end the lenses A and B, is divided into two parts, sliding in the principal tube S S S S fixed in the front of the camera at V V′.

Each tube has a strong pin, L and L′. These two pins are intended to push the tubes to and fro from the centre of the combination on the line P P′ by means of the mechanical piece N N′ N″ in the shape of a sextant, having two slits, M M and M′ M′, cut at an angle of 36°. Now the sextant, being mounted on a sliding bar $q\,q'$, fixed in a socket holding to the tube S S S S at P P′, can be made to move to and fro on the line P P′ by means of a rack and pinion moved by a handle V on the axis R. While the sextant moves in the line P P′, the two slits will act on the two pins, and gradually increase the separation of the tubes; and on making the sextant move back from P′ to P, the slits will bring the two pins nearer each other, and decrease the separation of the tubes.

It will thus be easily understood how we can increase and reduce the separation of the two lenses from the centre of the combination; but we have now to explain how we can produce the differential movement according to the mathematical formulæ calculated by Dr. Sommer.

The arc of the sextant is divided into 100 parts, in two rows one against the other. The divisions on the outer limb have their zero on the left,

and the 100 division on the right; on the inside limb the divisions are in a contrary direction.



By means of the endless screw X acting on the toothed edge of the sextant, it can be moved on its horizontal axis, so that any of its divisions may be brought under the index fixed on the middle bar $q\,q'$.

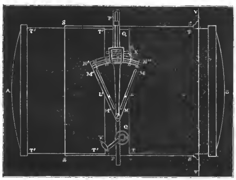
Now, supposing that by the table of Dr. Sommer the lens A for a certain distance of the object should move 0·235, and the lens B 0·765 of the whole space by which the lenses require to be separated or approximated, we turn the endless screw until the index is on the $23\frac{1}{2}$ division of the inside scale, and of course on the $76\frac{1}{2}$ division of the outside scale.

In that position of the sextant the slits M M and M′ M′, by means of the pins attached to the tubes of the lens A and of the lens B, will make them accordingly move—A in the proportion of 0·235, and B in the proportion of 0·765 of the whole space.

If for another distance the lens A should have to move 0·333, and the lens B 0·666, setting both limbs of the sextant to these divisions, the lens A will move $\frac{1}{3}$, and the lens B $\frac{2}{3}$ of the whole space.

If we wanted to move the two lenses in the same proportion, the sextant should be set so that the 50th division of both scales should be under the index.

And, finally, if, for the sake of comparative experiments, it were wanted to move only the lens A or the lens B, the slit of the pin for either and the zero of the scale should be placed under the index, by which that lens would be completely stationary, and the whole motion imparted to the other.



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